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Moisture Handbook

United States Department of Agriculture
Federal Grain Inspection Service

Program Handbook

September, 1986

FOREWORD

This Handbook sets forth the policies and procedures regarding the approval, alignment, calibration, operation, examination, and testing of moisture meters used in official inspection activities. The procedures contained in this Handbook are applicable to all Federal Grain Inspection Service (FGIS) Headquarters units, FGIS field offices, and agencies.

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CHAPTER 1. GENERAL INFORMATION

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CHAPTER 1. GENERAL INFORMATION

1.1 POLICY

A. Definition. Moisture is the water content of grain or related commodities ascertained by the air-oven method prescribed herein or by any method which gives equivalent results.

B. Requirements. Dependable, well-maintained, precision moisture meters are essential to the accurate inspection of all commodities[1]/. Poorly designed or manufactured meters and meters that are malfunctioning or misadjusted may cause incorrect determinations. To ensure the accuracy and integrity of official inspections, moisture meters used for official purposes must be:

1. A model and type[2]/ approved for use by FGIS which gives results equivalent to the air-oven method.

2. Installed, aligned, standardized, and calibrated according to the manufacturer's recommendations and the guidelines established by this Handbook and the appropriate Occupational Safety and Health Administration (OSHA) Standards.

3. Operated properly, utilize approved calibration constants, maintained in good repair, and tested at periodic intervals, in the prescribed manner, and found to be within tolerance.

C. Restrictions. Moisture meters which have serious operating deficiencies, do not operate within tolerance limitations, or have not been tested when required shall be considered to be not approved for official use and shall be removed from service until a subsequent test establishes their accuracy.

1/ The term "commodities," as used throughout the Handbook, means grain, rice, beans, lentils, and processed grain products.

2/ The mention of firm names or trade products does not imply that they are endorsed or recommended by the U.S. Department of Agriculture over other firms or similar products.

1.2 RESPONSIBILITIES

A. FGIS Headquarters.

1. Evaluate new models and/or types of meters.

2. Develop and maintain moisture meter calibration equations.

3. Maintain the National Standard and Headquarters Standard meters in good repair and ensure compliance with OSHA standards.

4. Test Headquarters Standard meter.

5. Provide samples for testing field office Standard meters.

6. Approve or reject field office Standard meters.

7. Maintain test records for Headquarters Standard and field office Standard meters.

B. FGIS Field Offices.

1. Maintain field office meters[1]/ in good repair and ensure compliance with OSHA standards.

2. Designate an equipment specialist who will serve as the primary contact responsible for meter testing.

3. Identify and test field office Standard meter (meter aligned with the Headquarters Standard).

4. Provide samples for testing field office and agency meters[1]/.

5. Test field office meters[1]/.

6. Supervise testing performed by agencies.

7. Approve or reject FGIS field office and agency meters[1]/.

8. Maintain test records for FGIS field office and agency meters[1]/.

C. Agencies.

1. Designate an equipment specialist who will serve as the primary contact responsible for equipment testing.

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[1]/ Including meters provided for official use by a facility.

2. Maintain agency meters[1]/ in good repair and ensure compliance with OSHA standards.

3. Test agency meters[1]/.

4. Maintain test records for agency meters[1]/.

1.3 RECORDKEEPING REQUIREMENTS

A. FGIS Headquarters. The office in charge of the inspection equipment testing program shall maintain completed test forms for at least 5 years from the date of the test for National Standard and Headquarters Standard meters and field office Standard meters.

B. FGIS Field Offices. FGIS field offices shall maintain completed test forms for at least 5 years from the date of the test for field office Standard meters, field office meters (other than field office Standard), and agency meters.

C. Agencies. Agencies shall maintain completed test forms for at least 5 years from the date of the test for all of their meters.

1.4 EQUIPMENT IDENTIFICATION

A. Serial Number. All moisture meters shall be identified by a serial number. Meters which do not have a manufacturer's serial number shall be assigned a number by the owning office so as to provide a unique means of identification. That number shall be stamped or stenciled on the meter in a conspicuous location.

B. Test Decal. When a meter is approved, an FGIS test label (form FGIS-931, "Approved Label for Inspected Machinery" - figure 1) shall be affixed in a conspicuous location on the device. Meters which have serious operating deficiencies, do not operate within established tolerances, or which have not been tested according to schedule shall have their past test label(s) removed.

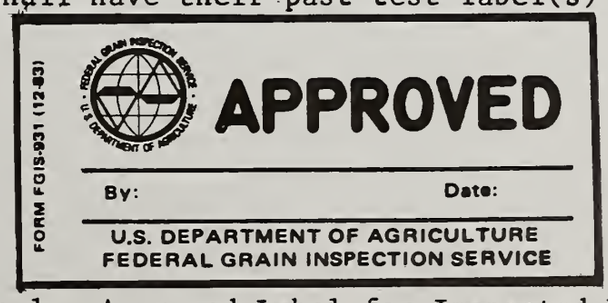

Figure 1. Approved Label for Inspected Machinery

1/ See Footnote Page 1.2

CHAPTER 2. PERFORMANCE REQUIREMENTS

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CHAPTER 2. PERFORMANCE REQUIREMENTS

2.1 POLICY

A. General. This chapter sets forth the minimum requirements for conducting tests and submitting test data to obtain approval of moisture meters for use in official measurement of constituents in grain, rice, and other commodities. The test requirements specified shall not preclude any additional testing and data submittal deemed necessary or desirable by the manufacturer. FGIS approval resulting from equipment compliance to this specification is limited in its application to FGIS official laboratory measurements and is not to be construed as meeting any other government or commercial requirements.

B. Manufacturer's Responsibility.

1. All testing and data recording shall be performed at the manufacturer's facility and expense, or at a test facility approved by the manufacturer and FGIS. FGIS will not assume responsibility for any costs incurred by manufacturer in performing the tests for which data is submitted nor will they be responsible for the accuracy of the data submitted.

2. Intentional submission of false data will be considered a violation of federal law and cause for a suspension or revocation of approval.

3. All test data submitted prior to approval shall be considered confidential unless otherwise specified by the manufacturer. After FGIS approval of the instrument, the data submitted for purposes of establishing conformance with these specifications shall be open to public review.

4. The manufacturer shall randomly select for testing a minimum of three instruments that are functionally identical to production units of that model and are manufactured using standard production procedures. Any changes made in the instrument design or manufactured parts after approval shall be reported to FGIS. Partial or complete retesting may be required depending on the change and its possible impact on instrument performance.

C. Test Program.

1. Prior to initiating the test program, the three test instruments shall be checked by the manufacturer to determine if they are operating electrically and mechanically in accordance with the manufacturer's specifications.

2. If an instrument fails to test in accordance with this chapter and can be brought into compliance by repair or adjustment, and this repair or adjustment can be demonstrated as not being an inherent instrument defect, then the repair shall be described and performed.

3. The test in which failure occurred shall be repeated in its entirety to assure compliance. Repeat of previously performed tests shall not be required. If the instrument fails any test and cannot be brought into compliance by adjustment or repair, then the manufacturer can select from production another instrument, but must perform on that unit all of the tests included in this chapter. The reason the instrument could not be brought into compliance and a justification why the noncompliance will not be repeated in other units of the same model must be submitted to FGIS.

D. Test Environment.

1. Temperature. The instrument shall be tested in an environmental chamber at the ambient, maximum and minimum temperatures that the instrument will encounter under normal operating conditions. The chamber temperature levels and tolerances for testing are defined as follows:

TEMPERATURE LEVEL	VALUE
Maximum	40 (± 2.5) degrees C
Ambient	20 (± 2.5) degrees C
Minimum	10 (± 2.5) degrees C

2. Relative Humidity. The instrument shall be tested in an environmental chamber at the high and ambient noncondensing relative humidity that the instrument would encounter under operating conditions. The relative humidity levels and tolerances for testing are defined as follows:

RELATIVE HUMIDITY LEVEL	RELATIVE HUMIDITY
High	90 (± 5) percent
Ambient	Less than, or equal to, 50%

E. Approval Limitations.

1. Approval by FGIS is limited to the instrument model tested and for the commodity type and class for which acceptable performance test data are submitted.

2. Approval for additional types and classes can be obtained by submitting concurrently, or at a later date, additional performance data covering these commodities.

3. For other instrument models produced by the same manufacturer, all, or part of, the tests included in this specification may be waived by FGIS if it can be shown by the manufacturer that there is no functional difference between the models.

F. Revocation and Reinstatement. Failure of an approved model to pass subsequent FGIS testing, or to provide reliable and accurate service, will be considered sufficient grounds to revoke FGIS approval. The instrument approval may be reinstated upon submission by the manufacturer of data confirming reliable and accurate performance.

2.2 REQUIREMENTS

A. Power Supply. The instrument shall operate on AC power and shall be tested at maximum, normal, and minimum voltages that the equipment would encounter under operating conditions. The line voltage levels for testing are defined as follows:

AC VOLTAGE LEVEL	VALUE
Maximum	132 VAC/60 Hz
Minimum	102 VAC/60 Hz
Normal	120 VAC/60 HZ

B. Vibration. The instrument shall be endurance tested in accordance with the requirements of the International Technical Commission, "Basic Environmental Testing Procedures," Publication 68-2-6, under the following conditions:

1. Endurance conditioning by sweep test.

2. Equipment mounted, but not operating.

3. 10-55 Hertz sweep range.

4. 1.5 hour test duration.

C. Storage Temperature. The instrument shall be capable of being stored at the following extremes of temperature without degrading the meter hardware performance at normal operating conditions.

TEMPERATURE LEVEL	VALUE
Maximum	65 (+ or - 5) degrees C
Minimum	-40 (+ or - 5) degrees C

D. Electromagnetic Susceptibility.

1. The instrument shall be tested under the following electromagnetic field conditions:

Field Strength:	3 Volts/meter
Frequencies:	27, 150, 460 MHz
Field Polarization:	Horizontal and Vertical
Modulation:	90 percent amplitude modulation at a one kilohertz rate and keyed on and off at a one hertz rate.

TEST	FREQUENCY	EXPOSURE AREA	POLARIZATION
1	27 MHz	front	vertical
2	27 MHz	back	vertical
3	27 MHz	right side	vertical
4	27 MHz	left side	vertical
5	27 MHz	front	horizontal
6	27 MHz	back	horizontal
7	27 MHz	right side	horizontal
8	27 MHz	left side	horizontal
9	150 MHz	front	vertical
10	150 MHz	back	vertical
11	150 MHz	right side	vertical
12	150 MHz	left side	vertical
13	150 MHz	front	horizontal
14	150 MHz	back	horizontal
15	150 MHz	right side	horizontal
16	150 MHz	left side	horizontal
17	460 MHz	front	vertical
18	460 MHz	back	vertical
19	460 MHz	right side	vertical
20	460 MHz	left side	vertical
21	460 MHz	front	horizontal
22	460 MHz	back	horizontal
23	460 MHz	right side	horizontal

2. The tests shall be performed in accordance with SAMA (Scientific Apparatus Makers Association, Washington, D.C.) Standard PMC 33.1-1978: "ELECTROMAGNETIC SUSCEPTIBILITY OF PROCESS CONTROL INSTRUMENTATION."

3. The manufacturer shall submit for FGIS approva[1] the methods and procedures used for electromagnetic susceptibility testing the instrument in compliance with SAMA Standard PMC 33.1-1978.

E. Leveling. The instrument shall operate within 3 degrees of an upright normal position to a level plane without any degradation in performance.

F. Life Test.

1. The instrument must perform 8,000 continuous measurements and conform to the instrument hardware performance requirements. If a failure occurs, the failure must be corrected and the test repeated until a total of 8,000 failureless continuous measurements have been completed. A fixture may be used to repetitively operate the instrument.

2. The instrument may be temporarily modified using an analog load to simulate a commodity. All mechanical motions performed during normal measurements shall be activated even though an actual commodity sample is not used.

3. The manufacturer may be required to show engineering data that the mechanical design employed will withstand normal utilization.

G. Hardware Performance.

1. Accuracy. The normalized root-mean-square difference (NRMSD) shall not exceed 1 for a moisture meter hardware accuracy specified (allowable) root-mean-square difference (SRMSD) of 0.1 percent.

2. Warm-up Time. The moisture meter shall attain hardware accuracy within 20 minutes of power turn-on.

3. Stabilized Readout. A stabilized display readout shall be obtained within 30 seconds of inserting the equivalent commodity sample load.

4. Display Resolution. The display shall permit determination of moisture to 0.1 percent.

H. Operational Performance.

1. Accuracy and Allowable Quality Limits. The NRMSD for any one moisture meter shall not exceed one. The Allowable Quality Limits (AQL) are that no more than 2.5 percent of the measurements may exceed a normalized positive sample error (NPSE) of +2.0 and no more than 2.5 percent of the measurement may exceed a normalized negative sample (NNSE) of -2.0. The meter operating ranges and specified root-mean-square difference (SRMSD) for the various commodities are as follows:

Types of Commodity	Percent Moisture On a Wet Basis		Specified Root-Mean-Square Difference[1]/ (SRMSD)
	Minimum/Ambient Temperature[2]/	Maximum Temperature[2]/	
Safflower Seed, Soybeans	7 - 25	7 - 12	0.03 of the percent moisture content, but no less than 0.4 percent in moisture content
Cereal Grains Except Corn, Rice, and Sorghum	7 - 25	7 - 16	
Corn and Sunflower Seed	7 - 30	7 - 16	0.035 of the percent moisture content, but no less than 0.5 percent in moisture content
Sorghum	7 - 25	7 - 16	
Rice and Other Commodities	7 - 25	7 - 12	

1/ All accuracies are referenced to the moisture content of the commodity determined by the air-oven method in accordance with Chapter 4 of this Handbook.

2/ Commodity sample and instrument are both at specified temperature.

2. Reproducibility. For a minimum of 10 measurements, each made by 3 or more moisture meters from the same sample, no more than 5 percent of the total samples measured (rounded to the nearest whole number) but not less than 1, may exceed the maximum average difference (MAD) limit. The specified MAD limits are as follows:

Moisture Range Percent	MAD Limit Percent
7 - 25	0.30
25 - 30	0.35

3. Precision. For a minimum of 10 measurements made on the same moisture meter using the same sample no more than 5 percent of the total sample as measured (rounded to the nearest whole number) but not less than 1, may exceed a normalized standard deviation (NSD) of 0.3.

I. Sample Preparation Equipment. Where additional equipment is required for preparation of samples for use by the instrument (e.g., grinders and scales) the equipment recommended by the manufacturer shall be used in accordance with the manufacturer's instructions and under ambient temperature, humidity, and normal line voltage. (The manufacturer may specify different ancillary equipment for different commodities.)

2.3 TEST PROCEDURES

A. Sample Selection.

1. Samples used in testing an instrument shall be representative of the commodities that will be measured by the instrument.

a. The manufacturer shall select, with the approval of FGIS, samples from a number of different geographical locations and, if available, from at least two United States crop years.

b. Samples selected shall have their constituent content uniformly distributed over the operating range of the instrument. Where a measurement dependence exists between constituents, then the constituent not being measured must be present in the samples selected with a range of values typical for the commodity tested.

2. The samples selected shall be equivalent to U.S. No. 2 or better.

a. The samples must be free of all known unusual factors which will adversely affect the constituent measurement. For example, pericarp damage in corn.

b. Samples must be properly sealed and stored to retain moisture content and to withstand deterioration. Samples exposure to air may be reduced by subdividing the original sample representatively into sublots where each sublot is used on a limited number of measurements.

3. The constituent and dependent constituent true content of each sample used in the performance evaluation tests must be determined, as appropriate to the test, using a standard laboratory procedure approved by FGIS.

4. A reference sample will be required for the life, hardware performance, storage, vibration, and electromagnetic susceptibility tests. A stable mid-range constituent and dependent constituent value sample or analog equivalent may be used.

5. The quantity of different samples required for operational performance testing is dependent on the constituent range and factors which can affect the constituent measurement. Some of these factors are number of geographical locations, number of crop years and other constituents or materials in the commodity that would affect the measurement.

B. Life Test.

1. Purpose. To demonstrate that the instrument will operate within the hardware accuracy given in the hardware performance requirements specification and in accordance with the life test requirements.

2. Test Equipment/Material Required.

a. Special fixture.

b. Reference sample.

3. Procedure. The life test shall be performed on the three selected instruments at specified ambient temperature and humidity, and normal line voltages. At the approximate instrument operation times corresponding to 0, 1200, 2400, 3600, 4800, 6000, and 8000 operating cycles, record 15 measurements (C_m) of the reference sample. For each instrument, at each operation time, calculate NRMSD.

4. Data Sheet - Life Test.

MOISTURE METER MANUFACTURER _____
METER NO. 1 TYPE/MODEL _____ SERIAL NO. _____
METER NO. 2 TYPE/MODEL _____ SERIAL NO. _____
METER NO. 3 TYPE/MODEL _____ SERIAL NO. _____

TIME	METER NO. 1 C_m	METER NO. 2 C_m	METER NO. 3 C_m
____	_____	_____	_____
____	_____	_____	_____
	- - - - - -	- - - - - -	- - - - - -
NRMSD	_____	_____	_____
ACCEPTABLE (YES,NO)	_____	_____	_____
CORRECTIVE ACTION	_____	_____	_____

REMARKS: _____

SUPERVISORY ENGINEER _____ TEST ENGINEER _____
DATE _____

C. Instrument Hardware Performance.

1. Purpose.

a. To determine that the instrument warm-up time stabilized readout time, and display resolution meet the hardware performance requirements.

b. To determine that the instrument, for voltage, temperature, and humidity variations within its normal operating environment, measures the constituent content of a reference sample equivalent load within the accuracy requirements of the hardware performance requirements.

2. Test Equipment/Material Required.

a. Reference sample.

b. Environmental chamber.

c. Variable transformer.

3. Procedure.

a. Warm-up Time, Stabilized Readout, and Display Resolution. This test shall be performed at specified ambient temperature, humidity, and normal line voltage. Shut-off the AC power on each of the three instruments for at least 1 hour. Turn on the power and after 4 hours, rapidly measure 15 times, the constituent content of the reference sample (C_m), the time it takes from inserting the sample to obtain a stabilized display (T_m), and the display resolution. Compute the NRMSD for each meter.

b. Accuracy. Place each of the three instruments in the environmental chamber. Insert the variable transformer into the meter's powerline. Record 15 measurements of the constituent content of the reference sample (C_m) under the specified test conditions. Compute the NRMSD for each meter.

4. Data Sheet - Meter Hardware Performance.

MOISTURE METER MANUFACTURER _____

METER NO. 1 TYPE/MODEL _____ SERIAL NO. _____

METER NO. 2 TYPE/MODEL _____ SERIAL NO. _____

METER NO. 3 TYPE/MODEL _____ SERIAL NO. _____

	METER NO. 1		METER NO. 2		METER NO. 3	
	C_m	T_m	C_m	T_m	C_m	T_m
	____	____	____	____	____	____
	____	____(1)	____	____(1)	____	____(1)
	____	____(15)	____	____(15)	____	____(15)
NRMSD	____	____	____	____	____	____
RESOLUTION	____	____	____	____	____	____
ACCEPTABLE (YES,NO)	____	____	____	____	____	____
CORRECTIVE ACTION	____	____	____	____	____	____

TEST	METER NO. 1 C_m	METER NO. 2 C_m	METER NO. 3 C_m
____	____	____	____
	____	____	____
NRMSD	____	____	____
ACCEPTABLE (Yes, No)	____	____	____
CORRECTIVE ACTION	____	____	____

REMARKS: _____

SUPERVISORY ENGINEER _____ TEST ENGINEER _____

DATE _____

D. Operational Performance Test.

1. Purpose. To determine that the instrument for voltage, temperature, and humidity variations within its normal operating environment, measures the constituent content of commodities in accordance with the operational performance requirements.

2. Test Equipment/Material Required.

a. Grain samples.

b. Environmental chamber.

3. Test Conditions.

a. The operational performance tests shall be performed for the specified moisture ranges under the following environmental test conditions:

Purpose	Meter		Sample		Minimum[1]/ Number of Samples	Number of Drops of Each Sample
	Temperature	Humidity	Temperature	Humidity		
Accuracy and AQL	ambient	ambient	ambient	ambient	3XRange	3
	maximum	ambient	maximum	ambient		
	minimum	ambient	minimum	ambient		
	ambient	high	ambient	high		
	ambient	ambient	ambient[2]/ +20 F	ambient		
	ambient	ambient	ambient[3]/ -20 F	ambient		
Reproducibility and Precision	ambient	ambient	ambient	ambient	1XRange[4]/	10
	maximum	ambient	maximum	ambient		
	minimum	ambient	minimum	ambient		

1/ For example, corn at ambient temperature, the moisture range is from 7 to 30 percent. The minimum number of samples required is 3 X (30 - 7) or 69 samples.

2/ Test on sample must be completed before it cools to a temperature of ambient + 15 F.

3/ Test on sample must be completed before it heats to a temperature of ambient - 15 F.

4/ These samples may be a subset of the samples used for the Accuracy and AQL test.

b. The reproducibility and precision measurement shall be performed cyclically, one commodity at a time, with each instrument performing every third measurement. The following analysis is performed to determine moisture loss (gain) during the measurement: For each instrument and sample compute the difference of the average moisture value between the first half (5) measurements and the second half (5) measurements. Normalize the difference by dividing by SRMSD. The sample data shall not be used if the normalized difference exceeds 0.1.

4. Procedure. Install the instruments in the environmental chamber. Measure the constituent content of the samples in accordance with the accuracy, AQL, precision, and reproducibility tests specified in the operational performance requirements.

The samples used for each test shall be sealed in air tight containers and stabilized to the temperatures specified.

5. Data Sheet - Operational Performance Test.

EQUIPMENT/MATERIAL REQUIRED

ENVIRONMENTAL CHAMBER TYPE/MODEL _____
ENVIRONMENTAL CHAMBER SERIAL NUMBER _____

SAMPLE NO.	GRAIN	CLASS	LOCATION	OVEN PERCENT MOISTURE

MOISTURE METER MANUFACTURER _____
METER NO. 1 TYPE/MODEL _____ SERIAL NO. _____
METER NO. 2 TYPE/MODEL _____ SERIAL NO. _____
METER NO. 3 TYPE/MODEL _____ SERIAL NO. _____

ACCURACY AND AQL ACCEPTANCE TESTS

RELATIVE HUMIDITY _____
TEMPERATURE _____
VOLTAGE _____

SAMPLE NO.	METER NO. 1			METER NO. 2			METER NO. 3		
	C_m	NPSE	NNSE	C_m	NPSE	NNSE	C_m	NPSE	NNSE

NRMSD			
% NPSE GREATER THAN AQL	_____	_____	_____
% NNSE GREATER THAN AQL	_____	_____	_____
ACCEPTABLE (YES,NO)	_____	_____	_____
CORRECTIVE ACTION	_____	_____	_____

PRECISION AND REPRODUCIBILITY TESTS

RELATIVE HUMIDITY _____
TEMPERATURE _____
VOLTAGE _____

SAMPLE NO.	METER NO. 1 C_m	METER NO. 2 C_m	METER NO. 3 C_m
1- _____	_____(1)	_____(1)	_____(1)
	_____(2)	_____(2)	_____(2)
	_____(10)	_____(10)	_____(10)
20- _____	_____(1)	_____(1)	_____(1)

A. PRECISION

1- _____	_____(NSD)	_____(NSD)	_____(NSD)
2- _____	_____	_____	_____
20- _____	_____	_____	_____
ACCEPTABLE (YES,NO)	_____	_____	_____
CORRECTIVE ACTION	_____	_____	_____

B. REPRODUCIBILITY

1- _____	_____(Av. C_m)	_____(Av. C_m)	_____(Av. C_m
			_____(MAD)
2- _____	_____	_____	_____
			_____
20- _____	_____	_____	_____
			_____
ACCEPTABLE (YES,NO)	_____	_____	_____
CORRECTIVE ACTION	_____	_____	_____

REMARKS: _____
SUPERVISORY ENGINEER _____ TEST ENGINEER _____
DATE _____

E. Storage Temperature.

1. Purpose. To demonstrate that the instrument can be stored at extreme temperatures without affecting its operation at normal operating temperatures. The instrument after exposure to the extreme temperatures must measure the constituent content of a reference sample within the accuracy requirements of the hardware performance requirements specification.

2. Test Equipment/Material Required.

a. Reference sample.

b. Environmental chamber.

3. Procedure. Place the 3 instruments (power shut-off) in the environmental chamber and perform the following tests.

TEST	TEMPERATURE	EXPOSURE
1	Maximum	8 hours
2	Minimum	8 hours

After completing test 1, remove the instruments from the environmental chamber. Allow the instruments to reach room temperature and stabilize at room temperature for at least 4 hours. Take 15 constituent measurements with each instrument, using the reference sample and compute the NRMSD. The instruments are tested at specified ambient temperature, humidity, and normal line voltage. Repeat the procedure for test 2.

MOISTURE METER MANUFACTURER _____

METER NO. 1 TYPE/MODEL _____ SERIAL NO. _____

METER NO. 2 TYPE/MODEL _____ SERIAL NO. _____

METER NO. 3 TYPE/MODEL _____ SERIAL NO. _____

TEST	METER NO. 1 C_m	METER NO. 2 C_m	METER NO. 3 C_m
	_____(1)	_____(1)	_____(1)
	_____(2)	_____(2)	_____(2)
	_____(15)	_____(15)	_____(15)
NRMSD	_____	_____	_____
CORRECTIVE ACTION	_____	_____	_____

REMARKS: _____

SUPERVISORY ENGINEER _____ TEST ENGINEER _____

DATE _____

F. Leveling.

1. Purpose. To demonstrate that the instrument may be oriented within three degrees of the upright normal position to a level plane without any degradation in performance. The instrument, when oriented within three degrees of the upright normal position to a level plane must measure the constituent content of a sample within the accuracy requirements.

2. Test Equipment/Material Required.

a. Three degree wedge.

b. One high valued constituent sample (No. 1).

c. One low valued constituent sample (No. 2).

d. Carpenter's level.

3. Procedure.

a. The level acceptance test requires one high constituent sample and one low constituent sample. The tests shall be performed at specified ambient temperature, humidity, and normal line voltage conditions.

b. Each of three instruments shall be used to measure the constituent content ten times. The measurements shall be performed cyclically, one sample at a time, with each instrument performing every third measurement.

c. The leveling acceptance tests shall be performed under the following test conditions:

TEST	CONDITION
1	Level
2	Front left corner raised 3 degrees
3	Front right corner raised 3 degrees
4	Back left corner raised 3 degrees
5	Back right corner raised 3 degrees

Obtain for test 1 through 5 the NSD for each meter and each sample.

4. Data Sheet - Leveling.

MOISTURE METER MANUFACTURER _____
METER NO. 1 TYPE/MODEL _____ SERIAL NO. _____
METER NO. 2 TYPE/MODEL _____ SERIAL NO. _____
METER NO. 3 TYPE/MODEL _____ SERIAL NO. _____

TEST	SAMPLE NO.	METER NO. 1	METER NO. 2	METER NO. 3
1.				
	1-_____	_____(1)	_____(1)	_____(1)
		_____(2)	_____(2)	_____(2)
		_____(10)	_____(10)	_____(10)
		_____(NSD)	_____(NSD)	_____(NSD)
	1-_____	_____(1)	_____(1)	_____(1)
		_____(10)	_____(10)	_____(10)
		_____(NSD)	_____(NSD)	_____(NSD)
	ACCEPTABLE (YES, NO)	_____	_____	_____
	CORRECTIVE ACTION	_____	_____	_____
5.				
	1-_____	_____(1)	_____(1)	_____(1)
		_____(2)	_____(2)	_____(2)
		_____(10)	_____(10)	_____(10)
		_____(NSD)	_____(NSD)	_____(NSD)

REMARKS: _____

SUPERVISORY ENGINEER _____ TEST ENGINEER _____
DATE _____

2.4 DEFINITIONS AND STATISTICAL PROCEDURES

A. Definitions.

1. Meter performance is measured in terms of accuracy, allowable quality limits (AQL), precision (repeatability), and reproducibility. These terms are defined as follows:

Accuracy:	The degree of conformity of a meter measurement to a standard or true value.
Allowable Quality Limit:	The maximum number of samples per 100 samples measured that may exceed a specified measurement limit.
Precision:	The degree of agreement of independent measurements of the same sample by repeated applications of the measurement instrument under specified conditions.

Reproducibility: The degree of agreement in the average of independent measurements of the same sample by different measurement instruments under the same specified conditions.

2. The measurement of meter performance is expressed in this specification as a ratio to the specified allowable constituent tolerance at each constituent content level. By using this normalization criteria the acceptable measured parameter variation at any constituent content is always less than or equal to unity. Contributing factors to the total parameter variation can be assessed as a fraction of this allowable unity value.

B. Statistical Procedure - Accuracy.

1. Accuracy is specified in terms of the normalized root-mean-square difference (NRMSD) and is defined as follows:

Let C_{11x}, C_{12x}, ...C_{1Mx}, C_{21x}, C_{22x}, ...C_{NMx} be the instrument determinations of the constituent on N samples of M measurements each for each of the x instruments.

Let R_1, R_2, ...R_N be reference method determinations of the constituent on N samples.

2. The specified root-mean-square difference (SRMSD) is the maximum root-mean-square difference measurement error allowable at a specified moisture content (tolerance).

$$NRMSD\ (x) = \sqrt{\frac{\left(\frac{C_{11x} - R_1}{SRMSD}\right)^2 + \left(\frac{C_{12x} - R_1}{SRMSD}\right)^2 + \ldots + \left(\frac{C_{NMx} - R_N}{SRMSD}\right)^2}{NM-1}}$$

3. The NRMSD is composed of a normalized bias error (NB) and a normalized random error (Normalized Standard Error of Performance, NSEP). The normalized bias error is defined as follows:

$$NB\ (x) = \frac{\left(\frac{C_{11x} - R_1}{SRMSD}\right) + \left(\frac{C_{12x} - R_1}{SRMSD}\right) + \ldots + \left(\frac{C_{NMx} - R_N}{SRMSD}\right)}{NM}$$

4. For a large number of samples the Normalized Standard Error of Performance (NSEP) is obtained using the following relationship:

$$NSEP\ (x) = \sqrt{NRMSD(x)^2 - NB(x)^2}$$

C. Statistical Procedure - AQL.

1. Allowable Quality Limits (AQL) specify the maximum percentage of measurement for an instrument that may exceed a given normalized positive sample error (NPSE), and a normalized negative sample error (NNSE) is the normalized difference between the sample's instrument and its reference method constituent determinations when the difference is positive.

2. The normalized negative sample error (NNSE) is the normalized difference between the sample's instrument and its reference method constituent determinations when the difference is negative. NPSE and NNSE are given by the following relationship:

$$NPSE\ (nmx) = \frac{C_{nmx} - R_n}{SRMSD} \qquad (C_{nmx} \text{ is greater than } R_n)$$

$$NNSE\ (nmx) = \frac{C_{nmx} - R_n}{SRMSD} \qquad (C_{nmx} \text{ is less than } R_n)$$

D. Statistical Procedure - Precision.

1. Precision is specifed in terms of normalized standard deviation NSD(n,x) for repeated measurements M made on the same sample n using the same meter x.

2. NSD(n,x) is defined as follows:

$$NSD(n,x) = \sqrt{\frac{\left(C_{n1x}^2 + C_{n2x}^2 + \ldots + C_{nMx}^2\right) - \frac{\left(C_{n1x} + C_{n2x} + \ldots + C_{nMx}\right)^2}{M}}{M-1}}$$

SRMSD

D. Statistical Procedure - Reproducibility.

1. Reproducibility is specified in terms of the maximum average difference MAD(n) and is equal to the maximum average sample measurement dfference measured by x meters using a sample n.

2. MAD(n) is given by the following relationship.

For each meter x calculate for sample N the average of M constituent measurements.

$$A(n,x) = \frac{C_{n1x} + C_{n2x} + \ldots + C_{nMx}}{M}$$

For the x meters find the maximum A(n,x) and the minimum A(n,x).

MAD(n) = Maximum A(n,x) - Minimum A(n,x)

E. Example for Utilizing the Statistical Relationship.

1. Data Used in Computing an Example of the Statistical Relationships.

Test	n	m	Constituent Measurement Percent Moisture Meter 1	Meter 2	Meter 3
Accuracy/AQL					
AQL Upper Limit = 2					
AQL Lower Limit = -2					
R = 12%	1	1	11.9		
SRMSD = 0.5%		2	12.3		
		3	12.1		
R = 16	2	1	16.4		
SRMSD = 0.56%		2	16.1		
		3	15.8		
R = 20%	3	1	21.0		
SMRSD = 0.7%		2	20.0		
		3	20.4		
Precision/ Reproducibility					
R = 12%	1	1	12.1	12.0	11.9
SMRSD = 0.5%		2	11.9	12.1	11.7
		3	12.3	12.2	12.1
		4	12.1	11.9	11.8
		5	12.0	11.8	12.0
		6	12.2	12.0	11.8
		7	12.0	12.0	12.0
		8	12.2	11.9	11.9
		9	12.0	12.1	11.8
		10	12.0	12.0	12.0

2. Data Developed to Compute Accuracy and AQL Based on Statistical Relationship Data.

x	n	m	R_n %	SRMSD %	C_{nmx} %	NPSE(nmx)	NNSE(nmx)	$\left(\frac{C_{nmx} - R_n}{SRMSD}\right)$
1	1	1	12	0.50	11.9		-0.20	0.040
		2	12	0.50	12.3	0.60		0.360
		3	12	0.50	12.1	0.20		0.040
1	2	4	16	0.56	16.4	0.71		0.504
		5	16	0.56	16.1	0.18		0.032
		6	16	0.56	15.8		-0.35	0.123
1	3	7	20	0.70	21.0	1.43		2.040
		8	20	0.70	20.0	0.00	0.00	0.000
		9	20	0.70	20.4	0.57		0.325
	Sum					3.69 (1)	-0.55 (2)	3.464 Sum

3. Computation of Accuracy.

$$NRMSD\ (x) = \sqrt{\frac{Sum\ (3)}{NM - 1}} = \sqrt{\frac{3.464}{8}} = 0.66$$

$$NB\ (x) = \frac{Sum\ (1) + Sum\ (2)}{NM} = \frac{3.69 - 0.55}{9} = 0.35$$

$$NSEP\ (x) = \sqrt{(0.66)^2 - (0.35)^2} = 0.56$$

4. Computation of AQL.

$$NNSE\ (nmx) = \frac{C_{nmx} - R_n}{SRMSD} = \frac{11.9 - 12.0}{0.5} = -0.20$$

$$NPSE\ (nmx) = \frac{C_{nmx} - R_n}{SRMSD} = \frac{12.3 - 12.0}{0.5} = 0.60$$

For meter 1, none of the NNSE exceeds the specified lower limit of -2 and none of the NPSE exceeds the specified upper limit of +2.

5. Data Developed to Compute Precison and Reproducibility Based on Statistical Relationship.

n	m	Meter 1		Meter 2		Meter 3	
		C_{1m1} %	C_{1m1}^2	C_{1m2} %	C_{1m2}^2	C_{1m3} %	C_{1m3}^2
1	1	12.1	146.41	12.0	144.00	11.9	141.61
	2	11.9	141.61	12.1	146.41	11.7	136.89
	3	12.3	151.29	12.2	148.84	12.1	146.41
	4	12.1	146.41	11.9	141.61	11.8	139.24
	5	12.0	144.00	11.8	139.24	12.0	144.00
	6	12.2	148.84	12.0	144.00	11.8	139.24
	7	12.0	144.00	12.0	144.00	12.0	144.00
	8	12.2	148.84	11.9	141.61	11.9	141.61
	9	12.0	144.00	12.1	146.41	11.8	139.24
	10	12.0	144.00	12.0	144.00	12.0	144.00
	Sum	120.8	1459.40	120.0	1440.12	119.0	1416.24

6. Calculation of Precision.

$$NSD\ (Sample\ 1, Meter\ 1) = \frac{\sqrt{1459.40 - \frac{(120.8)^2}{10}}}{\frac{10 - 1}{0.5}} = 0.246$$

NSD (Sample 1,Meter 2) = 0.231
NSD (Sample 1,Meter 3) = 0.249

7. Calculation of Reproducibility.

$$A\ (\text{Sample 1, Meter 1}) = \frac{\text{Sum of } C_{1m1}}{M} = \frac{120.8}{10} = 12.08\%$$

A (Sample 1, Meter 2) = 12.00%

A (Sample 1, Meter 3) = 11.90%

MAD(Sample 1) = 12.08 - 11.90 = 0.18

CHAPTER 3. CALIBRATION EQUATIONS

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CHAPTER 3. CALIBRATION EQUATIONS

3.1 INTRODUCTION

FGIS develops and periodically reverifies the accuracy of all moisture meter calibration equations used for official purposes. FGIS reverifies the calibration equations for the major grains inspected under the United States Grain Standards Act and rough rice annualy. All other equations are reverified on a 9-year cycle.

3.2 REVIEW SCHEDULE

A. Calibration Equations Requiring Annual Review. Corn, Durum wheat, Eastern White wheat, Western White wheat, Hard Red Spring wheat, Hard Red Winter wheat, Soft Red Winter wheat, Sunflower Seed, Sorghum, Soybeans, Two-rowed and Six-rowed Barley, Oats, Long Grain Rough Rice, Medium Grain Rough Rice, and Short Grain Rough Rice.

B. Calibration Equations Requiring 9-year Cyclical Review.

1. Cycle Years 1-3. Flaxseed, Rye, Triticale, Blackeye beans, Black Turtle Soup beans, Cranberry beans, Great Northern beans, Kidney (Dark) beans, Kidney (Light) beans, Lima (Baby) beans, Lima (Large) beans, Lima (Throgreen) beans, Navy beans, and Pink beans.

2. Cycle Years 4-6. Pinto beans, Small Red beans, Small White beans, White (Flat) beans, Yelloweye beans, Lentils, Wrinkled Winter peas, Smooth Dry peas, Split peas, Wrinkled peas, Long Grain Brown Rice for Processing, Medium Grain Brown Rice for Processing, Short Grain Brown Rice for Processing, and Long Grain Brown Rice for Processing-Parboiled.

3. Cycle Years 7-9. Rapeseed, Long Grain Milled Rice, Medium Grain Milled Rice, Short Grain Milled Rice, Long Grain Milled Rice-Parboiled, Medium Grain Milled Rice-Parboiled, Milled Rice Coated, Brewers and Screenings Milled Rice, and Brewers Milled Rice- Parboiled, Long, Medium, and Short Grain Second Head Milled Rice.

NOTE: The 1987 harvest period is cycle year 1.

3.3 EQUIPMENT REQUIREMENTS

A. FGIS Field Office Equipment. Only use approved moisture meters and test weight per bushel apparatuses maintained and tested in accordance with this handbook and the Equipment Handbook.

B. Quality Control and Testing Branch (QCTB) Equipment.

1. Moisture Meters.

a. Only use approved moisture meters maintained in accordance with this handbook.

b. Once every three months, test each meter against the FGIS National Standard meter in accordance with the direct comparison procedures in this handbook using samples traceable to the air-oven.

c. Once a month, check each meter against the USDA air-oven method.

(1) Use three recent-crop Hard Red Winter wheat samples of approximately 8.0, 12.0, and 16.0 percent moisture. (For meters that are not approved for wheat, use three samples of the predominate grain for which each particular meter is approved.)

(2) Plot and compare the results against, previous results and the results of other meters to determine if any meter is drifting.

(3) If drifting is detected, remove the meter from service and recalibrate or repair.

d. Once a day, check each meter using a bulk reference sample of dockage-free Hard Red Winter wheat between 11.0 and 13.0 percent moisture. (For meters that are not approved for wheat, use a sample of the predominate grain for which each particular meter is approved.)

(1) Keep the bulk reference sample stored in a moisture-proof container.

(2) Plot and compare the daily check results against previous results and the results of other meters to determine if any meter is drifting.

(3) If drifting is detected, remove the meter from service and recalibrate or repair.

2. Test Weight Per Bushel Apparatuses. Only use approved test weight per bushel apparatuses maintained and tested in accordance with the Equipment Handbook.

3. Air-Ovens.

a. Monitor the temperature of the air-ovens using a continuous temperature recording device.

b. Once a month, check the temperature of the air-ovens using a thermometer traceable to the National Bureau of Standards to check the accuracy of oven thermocouples.

c. Test check samples received from the various check sample services (e.g., American Association of Cereal Chemists).

d. Each April, check the uniformity of the sample moisture analysis within each oven by running replicate moisture analyses of the same sample placed in the oven at the four useable corners and in the center of the shelf. Plot and compare the results against previous results and the results of other ovens to determine oven accuracy and stability.

NOTE: A complete record of each of the aforementioned equipment tests or checks and any corrective action taken shall be maintained on file by QCTB for 3 years.

3.4 SAMPLE COLLECTION PLAN

A. General. QCTB develops and implements an annual sample collection plan for those commodities scheduled for review or new calibration equation development. The collected samples shall represent the entire official measurable moisture range for each affected commodity.

B. Work Schedule.

1. By no later than March 1, QCTB submits for publication a sample collection plan for that calendar year. The plan shall specify precisely which calibration equations are being evaluated, which offices are responsible for submitting what type of samples, and the number of samples needed from each moisture range.

2. By no later than November 1, all affected FGIS field offices shall submit all requested samples to QCTB.

3. By no later than January 1, QCTB shall issue a report of survey samples received. The report shall include the commodities received by class and moisture ranges, and the actual number received in each class.

C. Basic Sample Criteria. The following is the moisture range and the approximate number of samples required to evaluate the calibration equations:

Commodity	Approximate Moisture Range	Approximate Number of Samples
Barley - 2 and 6 row	8 to 20	60
Corn	8 to 30	260
Flaxseed	5 to 15	40
Oats	8 to 20	80
Rye	8 to 20	60
Sorghum	8 to 25	60
Soybeans	8 to 20	210
Sunflower Seed	6 to 25	180
Triticale	7 to 14	60
Wheat - Durum	7 to 20	70
Wheat - Eastern White	8 to 20	60
- Western White	8 to 20	60
- Hard Red Spring	7 to 20	70
- Hard Red Winter	8 to 20	70
- Soft Red Winter	7 to 20	60
Beans	8 to 20	40 (per kind)
Lentils	7 to 20	50
Wrinkled Winter Peas	7 to 20	50
All Other Kind of Peas	8 to 20	50 (per kind)
Rapeseed	8 to 20	50
Rough Rice	7 to 30	80 (per class)
Brown Rice	7 to 20	60 (per class)
Milled Rice	7 to 20	60 (per class)
Parboiled Rice	7 to 20	60 (per class)
Coated Rice	10 to 20	50
Brewers Rice	10 to 20	50 (per class)
Second Head Rice	10 to 20	50 (per class)

D. Sample Collection Procedures.

1. FGIS field offices shall:

a. Contact potential sources for samples well ahead of the collection period.

(1) Primary contact - official agencies.

(2) Secondary contacts - elevators, county agents, farmers, and processors.

(3) High-moisture grain contact - farmers.

b. Supply each contact with plastic and canvas bags, and mailing tags. Mark the moisture range and type of commodity on the back of each mailing tag.

c. Provide high-moisture grain contacts with express-mail tags and request that the contacts refrigerate all high-moisture samples immediately.

d. Instruct each contact to send all samples, except high-moisture samples, to the field office as soon as possible after drawing it. High-moisture samples shall be sent directly to QCTB via overnight mail.

e. Upon receipt of a sample, determine the moisture content and test weight per bushel of the sample; and record the test results on the back of the "Moisture Survey Sample" mail tags (attachment 1).

f. After testing the sample, prepare the sample for shipment to QCTB by reducing it to 1,500 grams and sealing the sample in a polyethylene bag.

g. Insert the sample bag into a canvas bag, and attach the mailing tag. For samples over 13 percent moisture, stamp the tag "Priority."

NOTE: Test and forward samples to QCTB as they are received. Do not hold samples.

2. QCTB shall contact and obtain samples from State universities, private laboratories, and industry sources.

3.5 SAMPLE TESTING AND EVALUATION

A. Test Preparation.

1. Upon receipt of a sample, QCTB shall assign the sample an identification number and record the date received on a tally sheet or a computer record.

2. Immediately prior to testing, QCTB shall:

a. Pour each sample into a pan and determine the condition, odor and test weight[1]/ of the samples.

1/ All factor determinations and equipment operations shall be performed in accordance with the procedures set forth in Book II, Grain Inspection Handbook.

b. Record the condition, odor, and test weight per bushel on a data sheet. Test weight shall be recorded to tenths.

c. Blend and then divide each sample into two separate portions for meter and oven analysis. Each portion shall be placed in an air-tight container and sealed.

B. Testing the Samples.

1. Moisture Meter Test.

a. QCTB shall reduce the meter sample to the appropriate amount for meter analysis and then test the sample three times at room temperature using the QCTB Standard meters.

b. Every fourth sample (or as specified) shall be tested at approximately 40°, 50°, 60°, 80°, and 95° F, and room temperature. Each sample shall be tested three times by each meter at each temperature level.

c. The results of all tests shall be recorded on a data sheet or a computer record.

d. Upon completion of test, the samples shall be returned to their air-tight containers and sealed.

2. Air-Oven Test.

a. QCTB shall reduce the air-oven sample to the appropriate amount for air-oven analysis and test the sample. Air-oven determinations and equipment operations shall be performed in accordance with the procedures set forth in Chapter 4.

b. The results of all tests shall be recorded on a data sheet or a computer record.

3. Disposition of Samples. Samples shall be retained at 35°- 40° F in air-tight containers until all test results are received.

C. Evaluation of Results.

1. Upon completion of all tests on a particular commodity, QCTB shall transfer all data to the computer for statistical evaluation by the Marketing Research and Development Division, Agricultural Marketing Service (MRDD-AMS). The data shall be made available to MRDD-AMS no later than 120 days prior to the established "Calibration Change Date" (attachment 2).

2. MRDD-AMS shall perform the following analyses on the data:

a. Estimation of error tendencies, including bias;

b. Estimation of measures of variation, including standard error and root mean square error; and

c. Regression and variance analysis, including trend investigations and calibration estimates covering the data for the three most recent crop years.

3. All analyses shall be performed in accordance with generally accepted statistical procedures.

4. MRDD-AMS shall issue a "Report of Test" for each commodity evaluated. The report should be issued no later than 100 days prior to the established "Calibration Change Date."

5. QCTB shall evaluate the data and the report, and recommend a calibration equation change if any of the following conditions are found:

a. The average bias between meter and air-oven results is greater than $\pm$ 0.30 percent moisture for all commodities except corn. For corn the allowable bias shall be $\pm$ .30 percent up to 15.0 percent moisture and $\pm$ 0.50 percent moisture from 15.1 to the upper limit of the calibration.

b. A significant slope error in the calibration results with a difference (bias) which is greater than the allowable average bias between meter and air-oven results.

c. An inflection in the calibration results with a difference (bias) which is greater than the allowable average bias between meter and air-oven results.

6. QCTB shall issue a report to the Director, Field Management Division, of their evaluation, including any recommendation for changes by no later than 60 days, prior to the "Calibration Change Date." The report shall also include an FGIS Program Bulletin which summarizes the evaluation and, when appropriate, announces a calibration equation change.

Reverse Side of Moisture Survey Sample Mailing Tag

Field Office Use Only	QCTB Use Only
F.O._____	QCTB No._____
Date_____	_____
Commodity_____	Remarks_____
Sub I.D._____	_____
Moisture_____	_____
Test Weight_____	_____

Attachment 2
MOISTURE HANDBOOK
Chapter 3
9-15-86

CALIBRATION CHANGE DATE

Commodity	Date
Barley	June
Corn	July
Flaxseed	August
Oats	June
Rye	June
Sorghum	May
Soybeans	July
Sunflower Seed	August
Triticale	June
Durum wheat	May
White wheat	May
Hard Red Spring wheat	June
Hard Red Winter wheat	April
Soft Red Winter wheat	April
Rapeseed	July
Beans (all kinds and classes)	July
Rice (all kinds and classes)	July

CHAPTER 4. AIR-OVEN METHODS

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CHAPTER 4. AIR-OVEN METHODS

4.1 GENERAL REQUIREMENTS

A. Representative portions. Since the determination of moisture content is made on a relatively small sample, it is extremely important that the portion used for analysis be representative of the sample as a whole.

B. Sample protection. Airtight containers should be used to protect samples of grain and other commodities from losing or gaining moisture before the moisture test is made. Careful handling of the samples is necessary if the test results are to be reliable. Samples to be tested for moisture content should not be unduly exposed to the air before or after grinding (if grinding is required). Samples of these commodities are extremely hygroscopic, even at 130° C. Therefore, moisture dishes must be covered and placed in a desiccator immediately upon removal from the oven.

C. Scale criteria. An analytical balance should be used in making moisture determinations. All weighings should be made to the nearest 0.1 mg.

D. Replicate determinations. Replicate determinations should check within 0.2 percent moisture.

4.2 EQUIPMENT REQUIREMENTS

A. Moisture dishes. Moisture dishes should be made of heavy-gauge aluminum that does not dent readily. The dishes should have a diameter of about 55 mm, a height of about 15 mm with slightly tapered sides, and should be provided with tightly fitting slip-in covers that fit snugly under the dishes when placed in the oven. Both the dish and its cover should be identified by the same number. Before using, dry the moisture dish for 1 hour at 130° C. or by an equivalent drying procedure, cool in a desiccator, and obtain the tare weight. Unless oily or other adhering materials are used, the tare weight of the dishes will not change more than a few tenths of a milligram during a year.

B. Desiccator. Desiccator should be airtight and should contain activated alumina, "Molecular Sieves" type 4A, 1/16" pellets (a product of Union Carbide Corporation, Linde Division), or other equally suitable desiccant. Silica gel and anhydrous calcium chloride are not suitable desiccants.

C. Oven. The oven may be of gravity-convection or mechanical-convection (forced-draft) type. It should be well insulated, maintain a reasonably uniform temperature throughout the chamber, and maintain the specified temperature at shelf level. A properly ventilated oven equipped with removable perforated or wire shelves and a suitable thermometer accurate to within 0.5° C. is required. To ensure uniformity of heating, ovens should be kept in operation continuously.

D. Mill. The mill should be of a type that is capable of grinding the sample without undue exposure to the atmosphere and without appreciable heating to avoid possible gain or loss of moisture. (Wiley Laboratory Mill, Intermediate Model, is preferred for this purpose.)

4.3 AIR-OVEN (130° C.) METHOD FOR WHEAT, BARLEY, OATS (INCLUDING WILD OATS), RYE, TRITICALE, SORGHUM, SOYBEANS, MIXED GRAIN, PEAS, LENTILS, AND RICE

A. One-stage procedure. This procedure may be used on all samples believed to contain 16 percent or less of moisture. If, after initial oven tests, the sample is found to contain more than 16 percent of moisture, the two-stage procedure must be followed. For soybeans, all samples having more than 10 percent of moisture should be tested by the two-stage procedure. In the case of rough rice (not brown or milled rice), all samples having more than 13 percent of moisture should be tested by the two-stage procedure.

1. Grind a representative 30- to 40-gram portion of the original sample so that all ground material will pass through an 18-mesh wire sieve (1.00 mm opening). 1/ Certain types of mills heat the sample during grinding. Such mills should not be used unless the mill is permitted to cool between grindings. The ground portion should pass directly from the mill into a suitable container not much larger than necessary to hold the portion.

2. Immediately after grinding, place representative subportions (duplicates at least) of approximately 2 to 3 grams each of the ground, well-mixed portion into tared moisture dishes.

3. Immediately cover the dishes and weigh. Subtract the weight of each dish from the total weight and record the result as the weight of the subportion.

1/ The 20-mesh (0.850 mm opening) wire sieve usually furnished with the Wiley Mill gives equivalent results to those obtained with the 18-mesh sieve. However, the use of the 18-mesh sieve reduces grinding time and lessens the packing problem, particularly with oats and barley.

4. Uncover the dishes and place them, with covers beneath, in the oven regulated to 130° ± 1° C. All moisture dishes should be placed on a single shelf in the oven. The bulb of the oven thermometer should be placed on the same level close to the dishes, but between, rather than over, the dishes.

5. After heating the material for 1 hour (timing begins when the oven reaches 130° C. after insertion of the dishes), remove the shelf containing the dishes, cover the dishes immediately and transfer them to a desiccator.

6. Weigh the dishes when they reach room temperature. Calculate the percentage of moisture by dividing the loss in weight due to heating by the weight of the original subportion and multiplying by 100.

B. Two-stage procedure. The two-stage procedure is used for all samples that contain 16 percent or more of moisture (10 percent in the case of soybeans and 13 percent in the case of rough rice).

1. Nearly fill two or more tared moisture dishes with representative portions of the unground sample. Subtract the weight of the dish from the total weight and record the weight of the portion.

2. Uncover the dishes and place them, with covers beneath, in a warm, well-ventilated place (preferably on top of the heated oven). The portions should dry reasonably quickly and reach an approximate air-dry condition. This usually takes from 14 to 16 hours when the top of the heated oven is used for this preliminary drying. In all cases, except for soybeans and rough rice, the moisture content must be reduced to 16 percent or less (10 percent in the case of soybeans and 13 percent in the case of rough rice) in this first stage of drying.

3. Cover the dishes containing the air-dried portions and weigh each of them soon after they reach room temperature. Determine the loss in weight of the portion and record it as the moisture loss due to air drying.

4. Using the air-dried sample, proceed in the manner described in the one-stage procedure.

5. Calculate the percentage of moisture in the original sample according to the method indicated in the following example:

a. Weight of the original portion used for the test (A)----27.2358 g

b. Weight of the portion after air drying (B)----25.1836 g

c. Moisture loss due to air drying (C)----2.0522 g

d. Weight of the ground subportion of the air-dried portion used for the 130° C. air-oven drying (D)----2.8753 g

e. Loss of moisture due to oven drying (E)----0.2974 g

f. Calculate the moisture content by substitution in the equation:

$$\% \text{ moisture} = \frac{\frac{EB}{D} + C}{A} \times 100$$

$$\% \text{ moisture} = \frac{\frac{0.2974 \times 25.1836}{2.8753} + 2.0522}{27.2358} \times 100 = 17.10\%$$

4.4 AIR-OVEN (103° C.) METHOD FOR CORN AND BEANS

A. Place approximately 15 grams of a representative portion of the unground sample in each of two or more tared moisture dishes. For high-moisture-content corn (over 25 percent), use 100-gram portions instead of 15-gram portions for the determination.

B. Weigh the covered dishes and contents. Subtract the weight of each dish from the total weight and record the weight of the portion.

C. Uncover the dishes and place them, with covers beneath, for 72 hours in the oven regulated at 103° ± 1° C. The dishes should be placed on a single shelf with the bulb of the oven thermometer as close as possible to them, but between, rather than over, the dishes.

D. At the end of the heating period, remove the shelf containing the dishes, cover the dishes immediately, and place them in a desiccator.

E. Weigh the dishes when they reach room temperature. Calculate the percentage of moisture by dividing the loss in weight due to heating by the weight of the original sample and multiplying by 100.

4.5 AIR-OVEN (103° C.) METHOD FOR FLAXSEED

A. Place 5-7 grams of a representative portion of the unground flaxseed into each of two or more tared moisture dishes.

B. Weigh the covered dishes and contents. Subtract the weight of each dish from the total weight and record the result as the weight of the sample.

C. Uncover the dishes and place them, with covers beneath, for 4 hours in the oven regulated at 103° ± 1° C. The dishes should be placed on a single shelf with the bulb of the oven thermometer as close as possible to them, but between, rather than over, the dishes.

D. At the end of the heating period, remove the shelf containing the dishes, cover the dishes immediately, and place them in a desiccator.

E. Weigh the dishes when they reach room temperature.

F. Calculate the percentage of moisture by dividing the loss in weight due to heating by the weight of the original sample and multiplying by 100.

4.6 AIR-OVEN (130° C.) METHOD FOR SAFFLOWER SEED

A. Place approximately 10 grams of a representative portion of the unground safflower seed into each of two or more tared moisture dishes.

B. Weigh the covered dishes and contents. Subtract the weight of each dish from the total weight and record the result as the weight of the sample.

C. Uncover the dishes and place them, with covers beneath, for 1 hour in the oven regulated at 130° ± 1° C. The dishes should be placed on a single shelf with the bulb of the oven thermometer as close as possible to them, but between, rather than over, the dishes.

D. At the end of the heating period, remove the shelf containing the dishes, cover the dishes immediately, and place them in a desiccator.

E. Weigh the dishes when they reach room temperature.

F. Calculate the percentage of moisture by dividing the loss in weight due to heating by the weight of the original sample and multiplying by 100.

4.7 AIR-OVEN (130° C.) METHOD FOR SUNFLOWER SEED

A. Place approximately 10 grams of a representative portion of the unground sunflower seed into each of two or more tared moisture dishes.

B. Weigh the covered dishes and contents. Subtract the weight of each dish from the total weight and record the result as the weight of the sample.

C. Uncover the dishes and place them, with covers beneath, for 3 hours in the oven regulated at 130° $\pm$ 1° C. The dishes should be placed on a single shelf with the bulb of the oven thermometer as close as possible to them, but between, rather than over, the dishes.

D. At the end of the heating period, remove the shelf containing the dishes, cover the dishes immediately, and place them in a desiccator.

E. Weigh the dishes when they reach room temperature.

F. Calculate the percentage of moisture by dividing the loss in weight due to heating by the weight of the original sample and multiplying by 100.

CHAPTER 5. OPERATION AND TESTING OF MOTOMCO MOISTURE METERS

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CHAPTER 5. OPERATION AND TESTING OF MOTOMCO MOISTURE METERS

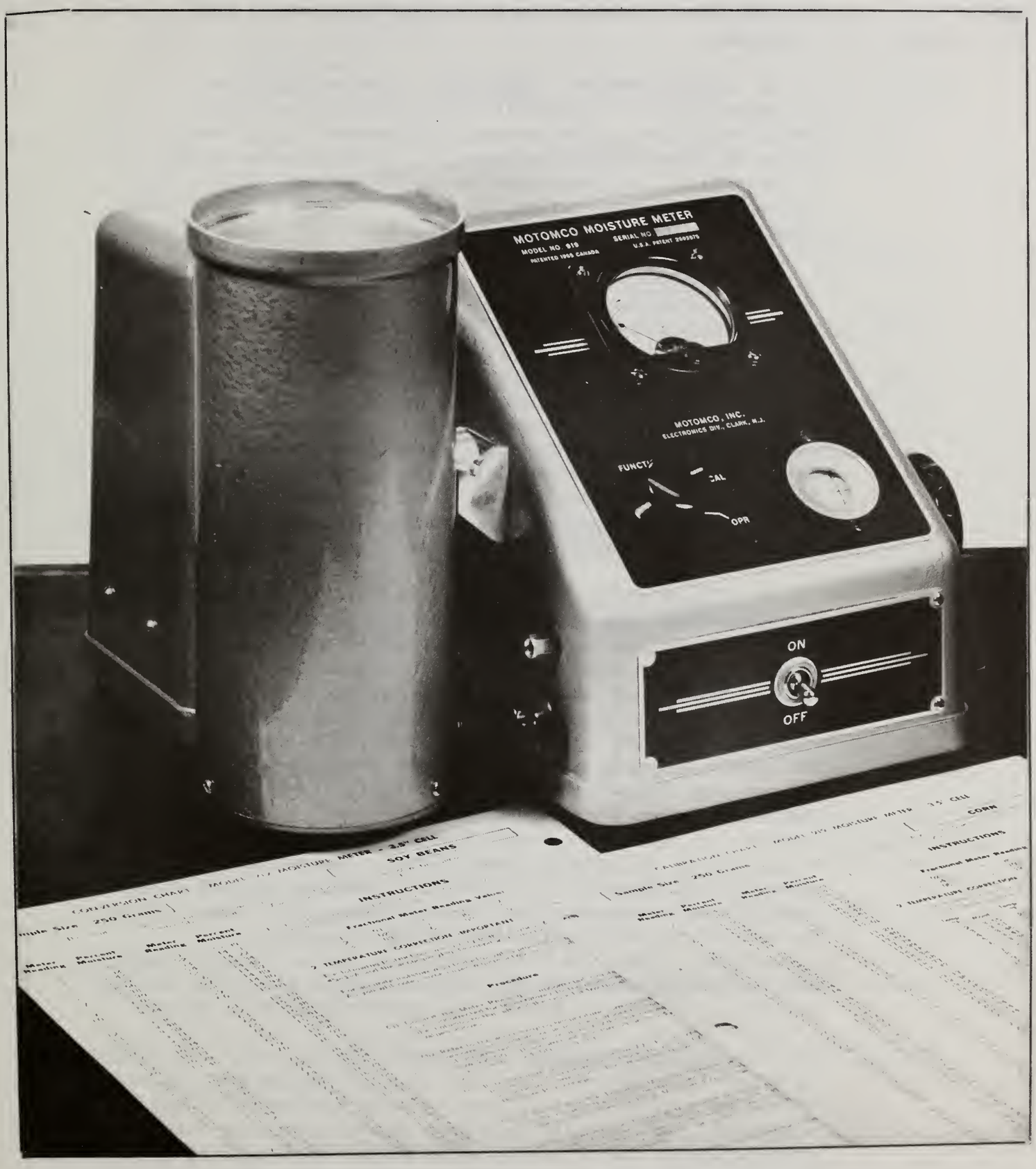

Figure 1. Motomco Moisture Meter, Model 919

5.1 MAINTENANCE, ALIGNMENT, AND CALIBRATION

A. Maintenance. Meters must be maintained in good operating condition. Check, align, and calibrate them prior to initial use and periodically thereafter, as needed. Each maintenance check shall encompass the following:

1. Environmental Conditions. Ensure that the moisture meter is placed in a room that is kept at a relatively stable temperature (20 degrees F. or less range of fluctuation) and free of direct air currents. If possible, install the meter in the center of the room, rather than against an outside wall. Temperature is more constant in the center of a room.

2. Lighting. Confirm that available natural or artifical lighting is adequate for reading the meter dial and for performing other related tasks.

3. Thermometer-Column Separation. Check each thermometer's indicating column for separation. If separated, carefully heat the thermometer in hot water and then vigorously shake it until the separation and the solid column enter the expansion chamber at the top of the thermometer. Allow the thermometer to cool slowly. Note: thermometers that have had this condition once are likely to have it again. Therefore, check such thermometers often.

4. Thermometer Uniformity. Check the uniformity of the thermometers. Place five or more thermometers in an insulated bottle (e.g., thermos) filled with 4 inches of room temperature tap water. Pack cloth around the top of the bottle opening and allow the temperature to equilibrate for one hour. Then, remove the packing and while the thermometers are still resting in the bottle, read each thermometer. Determine the mode result (the most frequent reading). Discard any thermometers that read more than 1.0 degree higher or lower than the mode.

5. Test Cell/Meter Connections. Ensure that the female connector on the test cell makes a properly aligned connection with the male connector on the meter housing. There should be no need to manipulate the cell to make this connection. Both the black insulator in the female connector and the pin assembly in the male connector should be solidly mounted. If play is noted, the meter should be repaired.

6. Test Cell Hanger. Determine if the test cell hanger is properly adjusted. The cell when placed on the hanger should make good physical contact with the meter at the cell connector. If the cell does not connect properly without some manipulation or if the milliameter does not return to the same null point when in the calibrate position, the meter should be repaired.

7. Dump Cell. Check the operation of the dump cell. When the two wings in the butterfly mechanism do not drop simultaneously, one of the release pins holding a wing may be longer than the other. This condition results in uneven distribution of grain into the test cell which, in turn, causes erroneous meter readings. Adjust the "too long" release pin by carefully filing it down or send it to a repair facility for adjustment.

8. Meter Knobs. Check the action of the knobs. Correct knob slippage by tightening the Allen setscrew on the affected knob.

9. Test Cell Cleaning. Foreign material or a film deposit in the test cell will affect test results. Thoroughly clean the inside of the test cell with a soft cloth moistened with soap and water. Do not immerse the cell in water or clean the cell with alcohol or solvents. Alcohol and solvents could damage the cell's plastic base and the plastic sleeve of the cell post.

10. Electrical Connections. Check the condition of the power cord, connections, and ensure that a grounded plug is used.

11. Line Voltage. Determine if the line voltage is constant. The starting and stopping of heavy motors or the operation of large electric equipment may cause a sudden surge or drop in power. If power is not constant, use a voltage regulator such as a Sola CV-S-Harmonic Neutralized transformer. Usually, only one meter should be operated through one voltage regulator.

B. Alignment. Upon receipt of a new meter and prior to all scheduled tests, check the meter for alignment as follows:

1. Position the function switch to CAL and then set the meter dial to 53;

2. Turn the calibration knob until the needle is at its null point;

3. Note the point on the milliameter at which null is reached; and

4. Repeat steps 1 - 3 at a level of 33 and 63.

The meter should null at the same point on the milliameter for 33 and 63 as it did for 53 (± one (1) scale division).

C. Calibration. Calibration corrects for existing temperature and humidity conditions. A meter will stay in calibration as long as these conditions remain constant, the calibration knob is not moved, and the test cell remains clean. Calibrate the meter upon receipt, each day prior to use, and, if practical, before testing each test sample. Calibrate the meter as follows:

1. Attach the test cell to the meter, place the on-off switch to ON, and allow the meter to warm up for at least one hour. After the meter has warmed up, place the function switch to CAL;

2. Position the meter dial to read the desired calibration level (33, 53, or 63). Rotate the calibration knob until the needle of the milliameter is at the lowest point possible, place the function switch to OPERATE.

3. Rotate the meter dial knob away from the calibration point, place the function switch to CAL, and then turn the knob until the needle of the milliameter is at the lowest point. Check the dial reading. This reading should correspond exactly with the calibration point which was set in step 2. If it does not, repeat steps 1 and 2.

5.2
OPERATION

A. Sample Preparation.

1. Pour a representative sample through a Boerner divider at least once before weighing out the required portion size. When weighing a sample, use a moisture-class scale. Adjust the sample weight by adding or removing a few kernels of grain from the scale scoop with your fingers until the scale is balanced.

NOTE: A 1.0 gram error in weight produces an error of 0.15 percent in the moisture determination.

2. Place the sample in a moisture-proof container. Insert a rubber-stoppered thermometer. Because of moisture losses incident to their use, paper bags, fiber cartons, etc., shall not be used as moisture sample containers. Containers found to be the most practical for use in determining moisture are moisture-proof, plastic, one-pint containers with approximately 1-3/4 inch openings.

NOTE: Do not file samples with paper identifications inserted in the grain. Paper absorbs moisture and lowers the moisture of the grain.

3. Exposure of cold samples to warm air may result in moisture condensation on the grain, leading to inaccurate moisture results.

a. Place cold samples in sealed, moisture-proof containers and keep them in the area where the moisture tests are to be performed.

b. Allow the samples to warm up to within 20 degrees of room temperature.

c. During the warming-up process, place the containers on a table in such a manner that there will be a free access of air to all sides. Placing the containers on a wire grating or rack has an additional advantage of exposing the bottom as well as the sides of the container to the air. Temperature equalization may be hastened by frequent shaking of the containers.

B. Sample Temperature.

1. Temperature must be accurately determined. Meters are standardized for a grain temperature of 77 degrees Fahrenheit. For temperatures other than 77 degrees Fahrenheit, a correction must be applied by referring to the appropriate conversion chart.

2. Because of wide variations between room and grain temperatures throughout the year, it is not possible to predict exactly how long after the thermometer has been inserted into the grain that the temperature should be read. Generally, 3 to 5 minutes are sufficient to obtain an accurate temperature.

3. Record the temperature of the sample to the nearest whole degree on the moisture log.

C. Moisture Determination.

1. Move function switch on the moisture meter to "OPR" (operate) position.

2. Pour the moisture sample from the container into the dump cell of the meter.

3. Firmly push the release button on the dump cell, dropping the portion into the test cell.

4. Rotate knob and observe needle until it reaches its lowest (null point) position on the scale to the far left.

5. Note the dial reading. Record the reading to the nearest 0.5 scale division on the moisture log. FGIS personnel shall use form IN-260 to record moisture determinations. Official agencies shall maintain a record of temperature and dial readings on a moisture log or the back of the pan ticket. If a pan ticket is used, all of the information shown on the moisture log shall be recorded, except the date, identification, and kind of grain.

6. Refer to the appropriate conversion chart and convert the meter reading into percentage of moisture; and make the necessary temperature correction to determine the actual percentage of moisture.

5.3 TESTING

A. Schedule.

1. Periodic Tests--Headquarters Standard and Field Office Standard Meters. These meters shall be tested in February and August.

2. Periodic Tests--Field Office and Agency Meters (Other Than the Field Office Standard).

a. Meters, other than those which are in storage or used only at seasonal points, shall be tested in March and September, whenever practical. The field office manager may, at his or her discretion, establish an alternate schedule; provided that, the alternate schedule requires the testing of all meters at least once every 6 months.

b. Meters held in storage shall not be tested until just prior to being put into service.

c. At seasonal inspection offices (those that are open less than 6 months a year), meters shall be tested once a year just prior to reactivation of the office.

3. Supplemental Tests. Meters shall be tested as soon as practicable whenever FGIS Headquarters, an FGIS field office, or an agency has comparative inspection results or other information which shows the meter to be of questionable accuracy; it becomes apparent that the meter has not been tested in accordance with the established testing schedule; or after any repairs, alterations, or rough handling. (A replacement of a minor part will not require the meter to be retested.)

B. Test Preparation.

1. Periodic Tests--Headquarters and Field Office Standard Meters.

a. FGIS Headquarters shall prepare test samples of Hard Red Winter wheat in accordance with the sample preparation procedures. (See section C, Test Procedures.)

b. A set of six samples (two for each moisture range) shall be provided to each field office and Headquarters for testing the field office and Headquarters Standards.

c. The samples shall first be tested by FGIS Headquarters using the Headquarters Standard (or using the National Standard for samples prepared for the Headquarters Standard); next, placed in moisture-proof containers, numbered from one to six; and then, mailed to the field and Headquarters offices for testing.

d. Each test sample shall be tested in accordance with the test procedures. (See section C, Test Procedures.)

2. Periodic Tests--Field Office and Agency Meters (Other than the Field Office Standard Meters).

a. The field office shall prepare test samples of Hard Red Winter wheat in accordance with the sample preparation procedures. (See section C, Test Procedures.)

b. A set of six samples (two for each moisture range) shall be provided for testing each field office and agency meter.

c. The samples shall first be tested by the field office using the field office Standard; next, placed in moisture-proof containers, numbered from one to six; and then, distributed to the appropriate locations for testing.

d. Each test sample shall be tested in accordance with the test procedures. (See section C, Test Procedures.)

3. Supplemental Tests.

a. The testing office (FGIS Headquarters, in the case of field office Standard meters, or the field office, in the case of all other meters) shall prepare a set of test samples (two for each moisture range) of Hard Red Winter wheat in accordance with the sample preparation procedures. (See section C, Test Procedures.)

b. The samples shall first be tested by the testing office (FGIS Headquarters or the field office, as appropriate) using the Headquarters or field office Standard, as applicable; next, placed in moisture-proof containers, numbered from one to six; and then, sent to the appropriate office.

c. Each test sample shall be tested in accordance with the test procedures. (See section C, Test Procedures.)

C. Test Procedures.

1. General. At the discretion of the testing office, moisture meters may be tested by either the direct comparison method or the sample exchange method. (The Headquarters Standard shall only be tested by the direct-comparison method.) Regardless of which test method is used, prepare the test samples in the following manner.

a. Assemble a set of six Hard Red Winter wheat samples which are between 12.0 and 14.0 percent actual moisture. Number the samples one through six.

b. Turn on the Standard meter and allow it to warm up for at least one hour.

c. Calibrate the Standard meter at 53. Then, turn it to the "OPR" position. Set the meter's dial to between 15 and 25 (with the test cell attached to the meter), remove the dump cell, and slowly pour the first sample (sample No. 1) of wheat directly into the test cell until the milliameter needle reaches its lowest point. Transfer the grain in the cell to a moisture-proof container and mark it No. 1. Repeat the procedure for sample No. 2 with a dial setting of between 25 and 35.

d. To prepare sample No. 3, set the meter's dial to between 35 and 45; for No. 4, set the meter's dial to between 45 and 55; for No. 5, set it between 55 and 65; and for No. 6, to between 65 and 75. Proceed in the same manner as stated above.

2. Direct Comparison Testing Method.

a. Thoroughly clean the test and the Standard meters. Connect both meters to the same constant voltage transformer. (Generally, only one meter should be connected to a voltage transformer. For direct comparison testing, however, it is preferable that both meters have the same input voltage so that both experience any power fluctuations to the same degree.)

b. Turn them both on and allow them to warm up for at least one hour. Mix sample No. 1 by dropping it through the dump cell of the test meter into the test cell six times. Calibrate both meters at 53 and then switch them to the "OPR" position.

c. Using the Standard meter, place the dump cell on the test cell and pour the sample into the dump cell.

d. Drop the sample from the dump cell to the test cell; record the meter reading on a slip of paper to the nearest one-tenth scale division.

e. Using the test meter, place the dump cell on the test cell and pour the sample into the dump cell. Drop the sample from the dump cell to the test cell and record the meter reading on a slip of paper to the nearest one-tenth scale division.

f. Repeat the procedure (steps c, d, and e) five times for sample No. 1. Record all readings for both the Standard meter and the test meter on a slip of paper.

g. Take the five test results for the Standard meter, mark through the low and high readings, and average the three remaining readings. Record the three remaining readings and their average on form FGIS-923 (attachment 1).

h. Take the five test results for the test meter, mark through the low and high readings, and average the three remaining readings. Record the three remaining readings and their average on form FGIS-923.

i. Do not determine the temperature of the sample. Temperature correction is not necessary for direct comparison testing.

j. For both Standard and test meter results, determine the average moisture content of the sample by converting the average meter reading to a percentage of moisture. (See IN Instruction 918-12.)

k. Return the sample to its moisture-proof container.

l. Test samples No. 2 through 6 by following steps b through k for each sample.

m. The testing office shall complete the form FGIS-923 and then compare the results of the test unit to the results of the Standard unit. If the mean deviations from the Standard are within the following tolerances, the meter is acceptable:

	Low	Mid	High
Headquarters Standard	± 0.05%	± 0.05%	± 0.05%
All other meters	± 0.15%	± 0.10%	± 0.15%

n. In the case of out-of-tolerance equipment, document on the form FGIS-923 all pertinent facts and actions (including retests and followup action).

o. After evaluating the test results, the original of the completed form FGIS-923 shall be given to the test unit owner. A copy of the form shall be retained by the testing office.

3. Exchange of Sample Method.

a. Thoroughly clean the meter, turn it on, and allow it to warm-up for one hour.

b. Mix sample No. 1 by dropping it through the dump cell into the test cell six times.

c. Calibrate the meter at 53. Then, turn it to the "OPR" position.

d. Place the dump cell on the test cell and pour the sample into the dump cell. Drop the sample from the dump cell to the test cell and record the meter reading on a slip of paper to the nearest one-tenth scale division.

e. Repeat the procedure (steps b, c, and d) five times and record all readings on a slip of paper. Disregard the low and the high readings, and record the three remaining readings and their average on form FGIS-923.

f. Determine the temperature of the sample to the nearest 0.5 degree F. A sealed, moisture-proof container must be used when obtaining temperature readings of test samples. To avoid temperature fluctuation during testing, place the samples near the meter for two hours before testing. Avoid testing near open doors, windows, or air-conditioning. Use only one thermometer during testing.

g. Record the temperature results on form FGIS-923.

h. Determine the average moisture content of the sample by converting the average meter reading to percentage moisture. Then, adjust the average for the temperature of the sample. (See IN Instruction 918-12.)

i. Test samples No. 2 through 6 by following steps b through h.

j. Return the samples in moisture-proof containers to FGIS Headquarters or the field office, as appropriate. Include a properly completed form FGIS-923.

k. Upon receipt of the returned forms and samples, FGIS Headquarters or the field office, as appropriate, shall complete the form by recording the Standard unit's results and then comparing these results to the test unit's results. If the mean deviations from the Standard are within the following tolerances, the meter is acceptable:

Low Range ± 0.20 % Mid Range ± 0.15 % High Range ± 0.20 %

l. In the case of out-of-tolerance equipment, document on the form FGIS-923 all pertinent facts and actions (including adjustments, retests, and followup action).

m. After evaluating the test results, the original copy of the form FGIS-923 shall be returned to the test unit owner. A copy of the form FGIS-923 shall be retained by the testing office.

5.4 REPAIR OF FGIS-OWNED MOISTURE METERS

A. General.

1. Standardization of FGIS-owned moisture meters can best be accomplished by ensuring that all repairs and adjustments not outlined in this chapter are made by Motomco, Inc., Shore Sales Company, or FGIS Headquarters. (Sealing of the meters by FGIS Headquarters ensures that unauthorized internal adjustments have not been made.)

2. Individuals who have been "factory trained" to make repairs and internal adjustments in prior years are no longer authorized to do so. Experience has shown that the accuracy of the meters can best be maintained by eliminating FGIS field office adjustments to them.

B. Repair Procedures.

1. FGIS field offices and FGIS Headquarters shall be responsible for determining the need for maintenance, calibration, and repair of malfunctioning FGIS-owned meters.

2. If maintenance, calibration, or repair is needed, send the meter to Motomco, Inc., or Shore Sales Company. If the meter is a field office Standard, also contact FGIS Headquarters.

3. To aid the manufacturer in determining the types of repairs needed, thoroughly describe the malfunction or operational difficulty, and provide any other pertinent information concerning the condition of the meter.

C. Packing the Meter.

1. Wood Containers.

a. The test and dump cells shall be packed inside a small cardboard carton.

b. The carton and meter shall be placed in the shipping container supplied by Motomco, Inc., or Shore Sales Company in accordance with the diagram provided with each container.

c. Do not forward the magnifying lenses with meters.

d. If the Styrofoam wedges used to secure the meter are missing, new wedges can be made from newspaper, cardboard, or other resilient material.

e. Wedges should be placed between the box and the meter to prevent movement and damage during shipment.

2. Cardboard Containers.

a. The meter, test cell, and dump cell shall be packed in the form-fitted foam base inside the container, the form-fitted top shall be placed on top of the meter, test cell, and dump cell.

b. Do not forward the magnifying lenses with meters.

D. Mailing Instructions.

1. Send meters to: Motomco, Inc.
267 Vreeland Avenue
Paterson, New Jersey 07543

or: Shore Sales Company
Airport Industrial Park
R.R. #2, Box 7A
Paxton, Illinois 60957

2. Do not enclose a franked mailing label for return of the meter. Mailing and handling charges will be included in the repair bill.

E. Testing Upon Return.

1. Upon return, the meter shall be tested against the FGIS field office or Headquarters Standard, as applicable. The testing shall be conducted in accordance with the procedures established by this chapter.

2. If the meter is not within tolerance, return it to Motomco, Inc., or Shore Sales Company for additional repairs and adjustments under the repair warranty.

3. FGIS field offices are requested to contact FGIS Headquarters with any questions pertaining to the repair and testing of moisture meters.

F. Warranty. In order for the warranty on meters to remain in effect, the seals placed on meters by Motomco, Inc., or Shore Sales Company shall not be broken. However, personnel may remove the rear bottom plate under which the fuse is located to check or replace the fuse.

G. Invoice-Receipt Certification.

1. All repair bills shall be sent to the National Finance Center (NFC) with a completed copy of form AD-838B, "Invoice-Receipt Certification." (See attachment 2.)

2. The form AD-838B shall be completed in accordance with NFC procedures required by Title II, Chapter 5, Section 1, Purchase Orders, and the instructions on the reverse of the form.

(Page Reserved)

FORM FGIS-923, "MOISTURE METER TEST"

U.S. DEPARTMENT OF AGRICULTURE
FEDERAL GRAIN INSPECTION SERVICE

MOISTURE METER TEST

NOTE: TEST METER OPERATOR, FILL IN SHADED AREAS ONLY

(1) DATE MAILED	(2) FIELD OFFICE	(3) AGENCY	(4) LOCATION
2-1-85	Chicago		Chicago, IL

INSTRUCTIONS: *Before starting – Review Chapter 5 of Equipment Handbook. (1) Inspect all mechanical components and electrical connections. (2) Calibrate meter at 33, 63, and 53. Low point reading of millimeter should be within one scale division at all 3 calibration points. (3) Leave meter calibrated at 53 for checktesting.*

TEST METER RESULTS		LOW RANGE		MID RANGE		HIGH RANGE	
(5) SERIAL NO. C12[illegible]	(6) TEST MATERIAL HARD	(7) MODULE VALUE ▶					
	SAMPLE	NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6
(8) TEMPERATURE OF TEST MATERIAL		76.0	75.5	75.0	75.0	75.0	75.0
METER READING – FIRST DROP		23.2	29.0	45.8	52.2	59.3	68.7
(9) – SECOND DROP		23.2	29.1	46.1	52.2	59.3	68.3
– THIRD DROP		23.1	29.1	46.0	52.0	59.2	68.5
(10) AVERAGE METER READING		23.2	29.1	46.0	52.1	59.3	68.5
(11) CHART [illegible] CONVERTED VALUE		9.24%	10.37%	13.62%	14.79%	16.18%	17.95%
(12) TEMPERATURE CORRECTION		+.05%	+.07%	+.10%	+.10%	+.10%	+.10%
(13) CORRECTED MOISTURE PERCENTAGE		9.29%	10.44%	13.72%	14.89%	16.28%	18.05%
(14) AVERAGE RESULTS		LOW RANGE 9.87 %		MID RANGE 14.31 %		HIGH RANGE 17.17 %	
(15) RESULTS BY: Patrick Wright	(16) DATE 2-[illegible]-85	(17) REMARKS:					

STANDARD METER RESULTS		LOW RANGE		MID RANGE		HIGH RANGE	
(18) SERIAL NO. N1[illegible]	(19) TEST MATERIAL HARD	(20) MODULE VALUE ▶					
	SAMPLE	NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6
(21) TEMPERATURE OF TEST MATERIAL		78.5	78.5	79.0	79.0	78.5	78.5
METER READING – FIRST DROP		22.7	29.6	47.3	53.6	60.5	70.5
(22) – SECOND DROP		22.5	29.6	47.2	53.4	60.3	70.6
– THIRD DROP		22.7	29.6	47.1	53.4	60.4	70.6
(23) AVERAGE METER READING		22.6	29.6	47.2	53.5	60.4	70.6
(24) CHART [illegible] CONVERTED VALUE		9.12%	10.47%	13.85%	15.06%	16.39%	18.35%
(25) TEMPERATURE CORRECTION		-.07%	-.07%	-.10%	-.10%	-.07%	-.07%
(26) CORRECTED MOISTURE PERCENTAGE		9.05%	10.40%	13.75%	14.96%	16.32%	18.28%
(27) AVERAGE RESULTS		LOW RANGE 9.73 %		MID RANGE 14.36 %		HIGH RANGE 17.30 %	
(28) RESULTS BY: George Harbig	(29) DATE 2-[illegible]-85	(30) REMARKS:					

SUMMARY OF RESULTS	LOW RANGE	MID RANGE	HIGH RANGE
(31) TEST METER RESULTS	9.87	14.31	17.17
(32) STANDARD METER RESULTS	9.73	14.36	17.30
(33) DEVIATION FROM STANDARD	+.14	-.05	-.13
Circle One: TOLERANCE – DIRECT COMPARISON	.15%	.10%	.15%
(34) – SAMPLE EXCHANGE	(.20%)	(.15%)	(.20%)
REVIEWED BY: (35)	DATE (36)		

RECOMMENDED ACTION: (37)
■ PLACE INTO SERVICE ☐ RETEST ☐ LOW RANGE ☐ MID RANGE ☐ HIGH RANGE ☐ FACTORY REPAIR

REMARKS: (38)

Attachment 1
MOISTURE HANDBOOK
Chapter 5
9-15-86

INSTRUCTIONS FOR COMPLETING FORM FGIS-923, "MOISTURE METER TEST"

1 Date test samples are mailed to the FGIS field office or agency, as applicable.

2 FGIS field office that performed the test, when applicable.

3 Agency that performed the test, when applicable.

4 Location of the field office or agency that performed the test.

5 Test meter's serial number.

6 "HRW."

7 Leave blank.

8 Temperature of the sample immediately after testing.

9 Three meter readings, shown to nearest tenth scale division.

10 Average of the meter readings, shown to the nearest tenth scale division.

11 "W-4."

12 Temperature correction, shown to the nearest hundredth percent.

13 Percentage moisture (average meter reading plus or minus temperature correction), shown to the nearest hundredth percent.

14 Rounded percentage moisture, shown to the nearest hundredth percent.

15 Name of person who tested the test meter.

16 Date that the testing of the test meter was completed.

17 Remarks.

18 Standard meter's serial number.

19 "HRW."

20 Leave blank.

21 Temperature of the sample immediately after testing.

22 Three meter readings, shown to nearest tenth scale division.

23 Average of the meter readings, shown to the nearest tenth scale division.

24 "W-4."

25 Temperature correction, shown to the nearest hundredth percent.

26 Percentage moisture (average meter reading plus or minus temperature correction), shown to the nearest hundredth percent.

27 Rounded percentage moisture, shown to the nearest hundredth percent.

28 Name of person who tested the Standard meter.

29 Date that the testing of the Standard meter was completed.

30 Remarks.

31 Test meter's average test results, shown to the nearest hundredth percent.

32 Standard meter's average test results, shown to the nearest hundredth percent.

33 Difference between the test meter's average and the Standard meter's average results. Show any plus or minus deviation from the Standard, including the appropriate sign.

34 Allowable deviations.

35 Name of person who determined whether the test meter was or was not in tolerance.

36 Date the determination was completed.

37 Check action recommended; i.e., if the meter clearly passes the test - check "place into service;" if the meter fails the test or if the reviewer is not satisfied with its performance - check "retest" and the range that is to be retested; and if the meter fails the tests and appears to need maintenance - check "factory repair."

38 Reviewer's remarks.

Attachment 2
MOISTURE HANDBOOK
Chapter 5
9-15-86

FORM AD-838B, "INVOICE-RECEIPT CERTIFICATION"

UNITED STATES DEPARTMENT OF AGRICULTURE

INVOICE – RECEIPT CERTIFICATION

1. PURCHASE ORDER NUMBER	2. TYPE SHIPMENT	3. DATE GOODS RECEIVED/SERVICE PERIOD END DATE (Month, Day, Year)	4. DATE INVOICE RECEIVED (Month, Day, Year)
43-6395-6-F8235	P		11/18/85

5. VENDOR INVOICE NUMBER	6. VENDOR NAME
R 0827	Motomco, Inc., 267 Vreeland Avenue, Paterson, NJ 07543

I certify the items billed were received, inspected, and accepted as complying with this order except as noted below.
Bill amounts are to be charged to corresponding line items on purchase order as follows:

7. P.O. LINE ITEM NO.	8 DESCRIPTION	9 QUANTITY/ UNIT ISSUE	10 DOLLAR AMOUNT	7. P.O. LINE ITEM NO.	8 DESCRIPTION	9 QUANTITY/ UNIT ISSUE	10 DOLLAR AMOUNT
01	Repair of Moisture Meter	1	$68.11				

+ Non-Merchandise Charge	11
+ Freight	12
+ Federal Excise Tax	13
+ State or Local Tax	14
Sub-Total	15 $68.11
– Trade-In	16
– Discount	17
– Credit	18
TOTAL	19 $ $68.11

20. RECEIPT EXCEPTION

AUTHORIZED OFFICIAL

21. ADDRESS
USDA, FGIS, P.O. Box 152, Stuttgart, AR 72160

22. SIGNATURE	23. DATE	24. PHONE (Area Code and Number)	FTS	COMM
Clyde Steves Field Office Manager	11/26/85	(501) 673-2508		x

25. Attach invoice and mail to: U.S. DEPARTMENT OF AGRICULTURE, National Finance Center
P.O. Box 60075, New Orleans, Louisiana 70160

FORM AD-838B (REV. 3/84)